

- 37 -

WHAT IS CLAIMED IS:

1. A method for characterizing a tissue, the method comprising:  
obtaining features of a Raman spectrum of the tissue in a first  
5 wavelength range;  
obtaining features of a background fluorescence spectrum of the tissue  
in a second wavelength range overlapping with the first wavelength range,  
wherein the background fluorescence spectrum is a background to the Raman  
spectrum in the first wavelength range; and,  
10 characterizing the tissue based upon at least the Raman spectrum  
features and the background fluorescence spectrum features.
2. A method according to claim 1 wherein the first and second wavelength ranges  
include wavelengths in the near infrared.
- 15 3. A method according to claim 1 or claim 2 wherein the first and second  
wavelength ranges are the same.
4. A method according to any one of claims 1 to 3 wherein the first and second  
20 wavelength ranges each include wavelengths from about 800 nm to about  
1000 nm.
5. A method according to any one of claims 1 to 4 wherein obtaining features of  
the background fluorescence spectrum and the Raman spectrum comprise

- 38 -

illuminating the section of tissue with incident light that is substantially monochromatic and obtaining a raw spectrum by detecting light backscattered from the tissue at a plurality of infrared wavelengths.

- 5     6.     A method according to claim 5 wherein the Raman features include a peak at a Raman shift of  $1445\text{ cm}^{-1}$  relative to a wavelength of the incident light.
7.     A method according to claim 5 or 6 wherein the Raman features include a peak at a Raman shift of  $1269\text{ cm}^{-1}$  relative to a wavelength of the incident light.
- 10
8.     A method according to any one of claims 5 to 7 wherein the Raman features include features within a band having a Raman shift in the range of about  $1200\text{ cm}^{-1}$  to about  $1400\text{ cm}^{-1}$  relative to a wavelength of the incident light.
- 15
9.     A method according to any one of claims 5 to 8 wherein the Raman features include features within a band having a Raman shift in the range of about  $1500\text{ cm}^{-1}$  to about  $1650\text{ cm}^{-1}$  relative to a wavelength of the incident light.
- 20     10.     A method according to claim 1 wherein obtaining features of the background fluorescence spectrum comprises illuminating the tissue with infrared light and obtaining a raw spectrum by detecting light backscattered from the tissue at a plurality of infrared wavelengths.

- 39 -

11. A method according to claim 10 wherein obtaining features of the Raman spectrum comprises extracting the features of the Raman spectrum from the raw spectrum.
- 5 12. A method according to claim 11 wherein extracting the features of the Raman spectrum from the raw spectrum comprises fitting a background fitting function to the raw spectrum to yield a fitted background function and subtracting the fitted background function from the raw spectrum.
- 10 13. A method according to claim 12 wherein the fitted background function comprises a polynomial.
14. A method according to claim 13 wherein the fitted background function comprises a fifth-order polynomial.
- 15 15. A method according to claim 12 wherein obtaining features of the background fluorescence spectrum comprises obtaining features of the fitted background function.
- 20 16. A method according to claim 10 wherein characterizing the tissue based upon at least the Raman spectrum features and the background fluorescence spectrum features comprises applying to the raw spectrum a classification function derived from principal components analysis.

- 40 -

17. A method according to claim 1 wherein characterizing the tissue based upon at least the Raman spectrum features and the background fluorescence spectrum features comprises applying to one or more datasets a classification function derived from principal components analysis, the one or more datasets collectively including the Raman spectrum features and the background fluorescence spectrum features.
18. A method according to claim 17 wherein the one or more datasets include one or more Raman spectrum PC scores and one or more background fluorescence spectrum PC scores.
19. A method according to claim 17 wherein applying the classification function comprises applying a predetermined principal component to data of the one or more datasets.
20. A method according to claim 17 wherein the tissue is skin of a part of a subject's body and the method comprises selecting a classification function corresponding to the part of the subject's body from a plurality of classification functions each corresponding to a different body region.
21. A method according to claim 20 wherein the plurality of classification functions includes classification functions corresponding to two or more of the following body parts: head, torso, hand, and arm or thigh.

- 41 -

22. A method according to claim 20 wherein the plurality of classification functions includes classification functions corresponding to two or more of the following body parts: head, torso, hand, arm or thigh, feet, legs, or nails.
- 5 23. A method according to claim 1 wherein characterizing the tissue comprises applying the Raman spectrum features and the background fluorescence spectrum features as inputs to a neural network.
- 10 24. A method according to any one of claims 1 to 23 where the section of tissue is a section of skin.
25. A method according to any one of claims 1 to 23 wherein the section of tissue comprises lung tissue.
- 15 26. A method according to any one of claims 1 to 23 wherein the section of tissue comprises epithelial tissue.
27. A method according to claim 26 wherein the epithelial tissue comprises tissue lining the subject's gastrointestinal tract.
- 20 28. A method according to claim 26 wherein the epithelial tissue comprises a lining of the subject's ear, nose or throat.

- 42 -

29. A method according to any of claims 1 to 23 applied to screening for skin cancer.
30. A method according to any one of claims 1 to 23 applied to screening for one or more diseases selected from the group consisting of: basal cell carcinoma, squamous cell carcinoma, melanoma and actinic keratosis.
31. A method according to any one of claims 1 to 23 applied to screening for one or more of: seborrheic keratosis, sebaceous hyperplasia, keratoacanthoma, lentigo, melanocytic nevi, dysplastic nevi, and blue nevi.
32. A method according to one of claims 6 and 7 wherein characterizing the tissue comprises indicating whether the tissue is likely affected by melanoma.
33. A method according to one of claims 6, 7 and 33 wherein characterizing the tissue comprises indicating whether the tissue is likely compound nevus tissue.
34. A method according to any one of claims 1 to 33 wherein the features of the Raman and autofluorescence spectra are acquired with the tissue in vivo.
35. A method according to claim 34 wherein the tissue is located below a tissue surface and acquiring the features of the Raman and autofluorescence spectra comprises detecting light from the tissue after the light has passed through overlying tissue.

- 43 -

36. A method according to any one of claims 1 to 35 comprising characterizing the tissue based upon an ultraviolet fluorescence spectrum in addition to the Raman spectrum features and the background fluorescence spectrum features.
- 5 37. A method according to any one of claims 1 to 36 comprising characterizing the tissue based upon a visible fluorescence spectrum in addition to the Raman spectrum features and the background fluorescence spectrum features.
38. A method according to any one of claims 1 to 37 comprising characterizing the  
10 tissue based upon a diffuse reflectance spectrum in addition to the Raman spectrum features and the background fluorescence spectrum features.
39. A method according to any one of claims 1 to 38 comprising characterizing the  
15 tissue based upon a light scattering spectrum in addition to the Raman spectrum features and the background fluorescence spectrum features.
40. A method according to any one of claims 1 to 39 comprising:  
obtaining features of at least one of a Raman spectrum and a  
background fluorescence spectrum of a control area of normal tissue of the  
20 subject;  
wherein characterizing the tissue is based, in part, upon a difference  
between one or more features of the Raman and background fluorescence  
spectra of the tissue and corresponding one or more features of the Raman and  
background fluorescence spectra of the control area.

- 44 -

41. A method for determining a melanin content of tissue, the method comprising:
- obtaining a spectrum of the tissue, the spectrum including first and second peaks at Raman shifts of approximately  $1368\text{ cm}^{-1}$  and  $1572\text{ cm}^{-1}$ ;
- subtracting a background of the spectrum to yield a Raman spectrum;
- 5                    computing the melanin content of the tissue based upon intensities of the first and second broad peaks in the Raman spectrum.
42. A method according to claim 41 wherein subtracting a background from the Raman spectrum comprises fitting a function to the spectrum and subtracting
- 10                   the fitted from the spectrum.
43. A method according to claim 41 wherein the fitted function is a second-order polynomial function.
- 15    44. Apparatus for characterizing tissues, the apparatus comprising:
- a light source for illuminating a section of tissue;
- an optical system configured to collect and direct backscattered light from the section of tissue into a spectrometer;
- a data processor connected to receive spectrum information for the
- 20                   backscattered light from the spectrometer;
- at least one classification function accessible to the data processor, the classification function producing a classification result in response to an input, the input including information about at least one Raman feature and at least one background autofluorescence feature of a spectrum of a tissue;



- 45 -

wherein the data processor is configured to apply the classification function to the spectrum information to obtain a corresponding classification result and to generate an output based upon the corresponding classification result, the output indicative of whether the section of tissue is likely to include abnormal tissue.

5

45. Apparatus according to claim 44 comprising a plurality of classification functions and a mechanism for permitting a user to select an appropriate one of the classification functions.

10

46. Methods comprising any new, useful and inventive step, act, combination of steps and/or acts, or subcombination of steps and/or acts described herein.

15

47. Apparatus comprising any new, useful and inventive feature, means, combination of features and/or means, or subcombination of features and/or means described herein.